Effect Of Led Exposure Time On The Temperature Rise, Depth Of Cure And Microhardness Of Nanohybrid Composite Resin

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Abstract

Background : It has been reported that depth of cure of composite resin can be achieved by prolonged light curing but causing temperature rise that could harm the pulp and resulted uncomfortable condition to patient. **Objectives:** To evaluate the effect of light-emitting-diode (LED) light curing unit on the temperature rise, depth of cure and microhardness of nanohybrid composite resin. Materials and Methods: Sixty specimens of nanohybrid composite resin (Tetric N Ceram, Ivoclar-Vivadent, Lichtenstein) with diameter of 5 mm, thickness of 5 mm were divided into 3 groups: Group I (n=20) were light-cured for 15 seconds, Group II (n=20) for 20 seconds, Group III (n=20) for 40 seconds using LED light curing unit (Hilux/Ledmax, Japan). The temperature rise was measured using digital thermometer at initial time to the highest temperature peak. The depth of cure was measured by scraping method. Microhardness was determined using Vickers Microhardness Tester at each 1 mm depth of the composite resin. Data were analyzed using Kruskal-Wallis and Mann-Whitney tests. **Results:** There were significant differences on temperature rise, depth of cure and hardness of nanohybrid composite resin at each 1 mm depth after light exposure time of 15, 20, and 40 seconds. The highest depth of cure was achieved after curing for 40 seconds but the highest microhardness was achieved after curing for 20 seconds at 1 mm from the top of specimens. **Conclusion:** Exposure time of 20 seconds produced low temperature rise, depth of cure and the highest VHN than the other exposure time.

Kata kunci: lama penyinaran, LED, kenaikan suhu, kedalaman polimerisasi, kekerasan, resin komposit nanohibrida

Pengaruh Lama Penyinaran Dengan Led Terhadap Kenaikan Suhu, Kedalaman Polimerisasi, Dan Kekerasan Resin Komposit Nanohibrida

Abstract

Latar belakang: Kedalaman polimerisasi yang baik dapat diperoleh dengan meningkatkan waktu penyinaran tetapi hal ini dapat menimbulkan kenaikan suhu pada pulpa sehingga pasien dapat saja merasa tidak nyaman. **Tujuan:**

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mengevaluasi pengaruh *light emitting diode* (LED) *ligh curing unit* terhadap kenaikan suhu, kedalaman polimerisasi, dan kekerasan resin komposit nanohibrida. **Bahan dan Cara:** Enam puluh spesimen resin komposit nanohibrida (Tetric N Ceram, Ivoclar-Vivadent, Lichtenstein) berdiameter 5 mm dan ketebalan 5 mm dibagi menjadi 3 kelompok; Kelompok I (n=20) disinar selama 15 detik, Kelompok II (n-=20) disinar selama 20 detik, Kelompok III (n=20) disinar selama 40 detik dengan menggunakan LED *light curing unit* (Hilux/Ledmax, Japan). Kenaikan suhu saat polimerisasi diukur dengan menggunakan termometer digital pada waktu awal penyinaran hingga mencapai suhu puncak. Kedalaman polimerisasi diukur dengan metode pengerokan. Sedangkan kekerasan resin komposit diukur dengan menggunakan Vickers Microhardness Tester pada setiap kedalaman 1 mm. **Hasil:** Berdasarkan analisa statistik menggunakan uji Kruskal Wallis dan Mann-Whitney terdapat perbedaan yang signifikan pada kenaikan suhu, kedalaman polimerisasi, dan kekerasan resin komposit nanohibrida pada setiap kedalaman 1 mm setelah penyinaran selama 15, 20, dan 40 detik. Kedalaman polimerisasi yang paling tinggi dicapai setelah penyinaran selama 40 detik tetapi kekerasan yang paling tinggi dicapai setelah penyinaran selama 20 detik pada setiap kedalaman 1 mm. **Kesimpulan:** Waktu penyinaran 20 detik menghasilkan kenaikan suhu yang rendah, kedalaman polimerisasi dan VHN yang paling tinggi dibandingkan dengan waktu penyinaran lainnya.

Kata kunci: lama penyinaran, LED, kenaikan suhu, kedalaman polimerisasi, kekerasan, resin komposit nanohibrida

Introduction

Nowadays, composite resin is often used in restorative dentistry. Recent composite resin is the nanohybrid light curing composite resin. Light-emitting-diode (LED) is one of the light curing unit often used in dentistry which has been reported to have temperature rise in tooth. It has been reported that higher depth of cure and microhardness of composite resin can be achieved by prolonged light curing.[1] However, this temperature rise could harm the pulp and resulted uncomfortable condition to patient.[2] Patients could feel pain on their tooth because of heat ranging from 39.5°C – 50.4 °C (average of 44.6 °C) with the beginning temperature ranging of 35.5°C – 36.1°C. In the first period of exposure to thermal stimulus, patient experienced "swelling" of the tooth followed by a slight localized pain which is constant or intermitent.[3] The purpose of this study was to evaluate the effect of light-emitting-diode (LED) light curing unit on the temperature rise, depth of cure and microhardness of nanohybrid composite resin.

Materials and Methods

Sixty specimens of nanohybrid composite resin (Tetric N Ceram, Ivoclar-Vivadent, Lichtenstein) with diameter of 5 mm, thickness of 5 mm were divided into 3 groups: Group I (n=20) were light-cured for 15 seconds, Group II (n=20) for 20 seconds, Group III (n=20) for

40 seconds using LED light curing unit (Hilux/Ledmax, Japan). The temperature rise was measured using digital thermometer at initial time to the highest temperature peak. The depth of cure was measured by scrapping method. Microhardness was determined using Vickers Microhardness Tester (Shimadzu, Japan) at each 1 mm depth of the composite resin. Data were statistically analyzed using Kruskal-Wallis and Mann-Whitney tests.

Results

Table 1 showed the average number of temperature rise of nanohybrid resin composite that was cured with LED for 15, 20 and 40 seconds. Statistically, there were significant differences of temperature rise between group I and II, and between group I and III. However, there was no significant differences between group II and III.

Tabel 1. Temperature Rise of Nanohybrid Resin Composite

Group	Curing Time (s)	N	Mean Temperatuere Rise (°C)
I	15	20	3,27
II	20	20	4,06
III	40	20	4,46

The temperature rise occured during 15, 20 and 40 seconds were shown in Figure 1. Comparing to group I, the highest temperature rise was seen at 30th second of light curing time in group III. Group I and III had the highest temperature rise 5 seconds after exposure time.

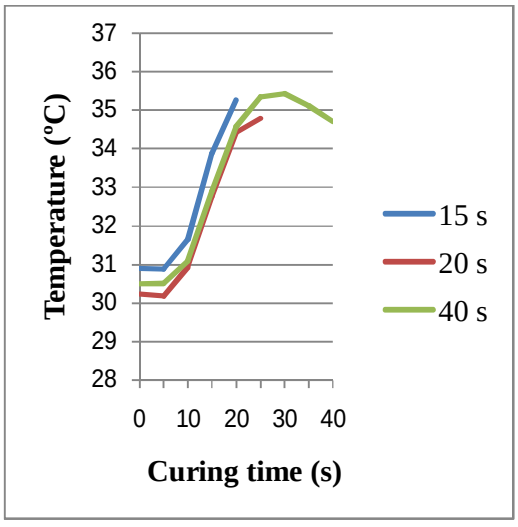

Figure 1: Temperature rise occured in15, 20, and 40 seconds time of LED light curing

Figure 1 showed that initial temperature from group I (15s) was 30.9 ℃, group II (20s) was 30,2 ℃ and group III (40s) was 30.49 ℃. The final temperature reached by group I (15s) was 35.26 ℃, group II (20s) was 34.77 ℃ and group III (40s) was 34.7 ℃. The highest temperature reached by group I was 35.26 ℃, group II was 34.77 ℃ and group III was 35.42 ℃.

Table 2 showed the average depth of cure which were obtained after curing for 15, 20, and 40 seconds. There were statistically significant differences between all groups. The comparison of depth of cure between all group could be seen on Figure 2.

Tabel 2: Depth of Cure of Nanohybrid Resin Composite

Group	Time (s)	Mean Depth of Cure (mm)
I	15	2.39
II	20	2.45
III	40	2.5

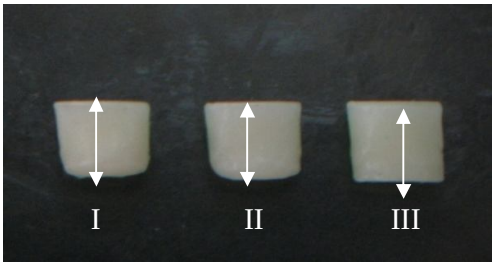

Figure 2. Depth of cure between groups after scrapping.

Table 3 showed the average of Vickers Hardness Number (VHN) of group I, II and III. There were significant differences on the microhardness of nanohybrid resin composite at each depth. The differences were between group I 15 s and group II 20 s at 1mm, 2mm, 3mm, 4mm of depth, between Group I 15 and Group III 40 s at 1mm, 2 mm, 3 mm, 4 mm, 5 mm depth and between Group II 20 s and Group III 40 s at 4 mm and 5 mm of composite resin depth.

Tabel 3. Microhardness of Nanohybrid Resin Composite at Each Depth

Depth (mm)	Group I: 15 Seconds (VHN)	Group II: 20Seconds (VHN)	Group III: 40 Seconds (VHN)
1	64.41	76.79	76.0
2	54.52	66.14	65.37
3	48.85	57.36	57.71
4	39.58	46.1	50.98
5	20.8	22.1	31.4

The temperature rise, depth of cure and hardness of nanohybrid composite resin at each 1 mm depth had significant differences after exposure time of 15, 20, and 40 seconds. The highest depth of cure was achieved after curing for 40 seconds but the highest microhardness was achieved after curing for 20 seconds at 1 mm from the top of specimens.

Discussion

According to this study, exposure time had an influence significantly on temperature rise of nanohybrid composite resin. Ebenezar (2010) noted that exposure time on each curing mode had a significant difference. The experiment used 2 types of different light curing unit (LCU) with gap between thermocouple K tips and LCU of 3 mm and 6 mm.[4]

From this study it was achieved that temperature rise of group I and II still increased even though the curing process had stopped whereas in group III, the highest temperature rise was noted at the 30th seconds (Figure 1.). The temperature rise had occured because of material-dependent such as filler combination, resin characteristic, composition and surrounding temperature. Previous study showed that composite resin materials had significant influence on temperature rise. [5] Other study showed that polymerization of composite resin was exothermic and directly related to resin volume. So, the lower the resin composition, the greater is the exothermic reaction.[6]

Dentin received heat that was produced by light curing source. The heat was then reduced within the pulp so the patient could not feel the temperature rise. A study by Ratih (2007) who had placed a thermocouple on the floor of the cavity and the second thermocouple was placed on the pulp-dentin junction (PDJ) showed that there were differences in temperature rise on the the floor of cavity and PDJ and that there were no correlation between temperature rise and dentinal fluid flow. [7]

In relation to this study, the exposure time of LED light curing influenced the depth of cure of nanohybrid composite resin. The increasing depth of cure could be seen from all groups of exposure time. It was shown that group I has the lowest depth of cure than group III. The increasing depth of cure occured because longer exposure time was needed to polimerize the deepest layer of composite resin. [8]

The longer exposure time could result in microhardness increase between all groups. However, the deepest layer at each group showed the lowest microhardness. The increasing microhardness between all groups occured because the longer exposure time led to the longer polimerization reaction.[9] The low microhardness at each layer of groups occured because light of the curing unit could not reach the deepest layer. The decreasing microhardness at each depth of composite resin occurred due to light absorbtion of the resin matrix and the spread of light from the filler. This condition reduced the polymerization of composite resin.[10]

Conclusion

It can be concluded that LED exposure time of 20 seconds produced the lowest temperature rise with highest microhardness of nanohybrid composite resin than other exposure times whereas the highest depth of cure was achieved in 40 seconds.

References:

1. Ota K, Kikuchi S, Kopel HM, Thanos CE, Nakamura RM. Effect of light exposire time on the depth of curing in various composite resin systems. Pediatric Dentistry 1985; 7(1): 19-22.
2. Albers HF. Tooth – Colored Restoratives Principles and Techniques. 9th ed. Hamilton: BC Decker Inc.; 2002. p. 82-125
3. Baldissara P, Catapano S, Scotti R. Clinical and histological evaluation of thermal injury thresholds in human teeth: a preliminary study. Journal of Oral Rehabilitation 1997; 24: 791-801.
4. Ebenezar AVJ, Anilkumar R, Indira R, Ramachandran S, Srinivasan MR. Comparison of temperature rise in the pulp chamber with different light curing units: an in vitro study. Journal of Conservative Dentistry 2010; 13(3): 132-135.
5. Hubbezoglu I, Dogan A, Bolayir G, Bek B. Effect of light curing modes and resin composites on temperature rise under human dentin: an in vitro study. Dent Mater J 2008; 27(4): 581-589.
6. Lloyd dan Brown dikutip dari Schneider LFJ, Cavalcante LMA, Tango RN, Consani S, Sinhoreti MAC, Sobrinho LC. Pulp chamber temperature changes during resin composite photo-activation. Braz J Oral Sci 2005; 4(12): 685-688.
7. Ratih DN, Palamara JEA, Messer HH. Temperature change, dentinal fluid flow and cuspal displacement during resin composite restoration. Journal of Oral Rehabilitation 2007; 34: 693-701
8. Baharav H, Abraham D, Cardash HS, Helft M . Effect of exposure time on the depth of polymerization of a visible light-cured composite resin. J of rehabil1988; 15:167-172.
9. Schneider LF, Consani S, Sinhoreti MA, Sobrinho LC, Milan FM, Temperature Change and Hardness With Different Resin Composites and Photo-activation Methods. Oper Dent. 2005 Jul/Aug; 30(4):516-21.
10. Ruyter IE, Oysaed H, Conversion in defferent depth of ultraviolet and visible ;ight activated composite materials. ActaOdontolScand, 40;179-192.